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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

(1)

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1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
June 15, 1994

3. REPORT TYPE AND DATES COVERED
Final Report 1 Sep 93-31 Aug 94

4. TITLE AND SUBTITLE
Scanning Tunneling Microscopy/Atomic Force Microscopy for Study of Nanoscale Metal Oxide Particles (Destructive Adsorbents)

5. FUNDING NUMBERS
DAAH04-93-G-0457

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JUL 13 1994
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
ARO 32398.1-CH-DPS

11. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
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12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
A modern scanning tunneling microscopy/atomic force microscopy instrument was purchased. This instrument is allowing physical characterization of nanoscale particles of metal oxides. These particles are known to be effective reagents for the destruction of military toxins as well as chlorocarbons by a process we call destructive adsorption.

DTIC QUALITY INSPECTED 5

94 7 12 060

14. SUBJECT TERMS
Nanoscale particles, destructive adsorption, atomic force microscopy, scanning, tunneling, scanning probe

15. NUMBER OF PAGES
9

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

AD-A281 417
94-21306
98

Scanning Tunneling Microscopy/Atomic
Force Microscopy for Study of Nanoscale
Metal Oxide Particles (Destructive Adsorbents)

Final Report
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I. Introduction

The development of solid reagents that adsorb and simultaneously destroy toxic substances is important for air purification and as an alternative to incineration. Toxic chemicals such as organophosphorus, -halogen, -sulfur, and nitrogen compounds are not very amenable to treatment by high performance catalytic processes since these heteroatoms are notorious for catalyst poisoning.

Solid reagents that might serve as effective destructive adsorbents must have high capacity, and convert the toxic materials to non-toxic substances. Ideally, the heteroatoms (P, Cl, Br, N, S) would be extracted from the organic parts of the molecules and "mineralized" (converted to an innocuous metal salt).

In attempts to synthesize and develop such destructive adsorbents, we have concentrated our efforts on nanoscale metal oxides. The development of the most efficient solid reagents depends on our ability to prepare ultrafine powder with very high surface areas and intrinsic surface reactivities.

This research direction leads us into the exciting field of nanostructured materials, which possess novel and hybrid properties between molecular and bulk solid limits. Metal and semiconductor nanoscale materials have already been demonstrated to possess unique magnetic, optical, and physical properties. We are contributing to this field by studying the unique surface chemistry of nanoscale <u>insulator</u> particles.

From these points of view, we believe that continued work on the chemistry of such particles has importance both to basic and applied science. Further understanding of their synthesis, properties, and chemistry <u>and</u> their development into useful materials is the driving

force behind the prior and proposed work described herein.

As an important aspect of characterizing these nanoparticles, a scanning tunneling microscope/atomic force microscope. (STM/AFM) was purchased. This instrument allows observation of the particles before and after use as destructive adsorbents. Morphological properties such as surface defects are believed to be responsible for the chemical reactivity with toxic chemicals (chemical agents, chlorocarbons, etc.). In order to understand and correlate defect types and concentrations with reactivity, STM/AFM experiments are now in progress.

II. Instrument Purchased

The STM/AFM instrument, model SPM 30, was purchased from WYCO corporation. The instrument consists of four major components: the microscope unit, the scanning probe interface, the stage/viewfinder controlled, and the computer system. To support the use of the microscope unit, a few necessary accessories were purchased, too. Those are two piezoelectric scanner modules of different scan-ranges, STM probe , AFM probe, probe holders, and cantilever carriers. An ink-jet printer and a color video copy processor were purchased from Hewlett Packard and Mitsubishi, respectively, to support the outcome of the resulting images.

III. Preliminary Results

Three MgO powder samples with different surface area and surface morphology were studied by AFM. The surface area was 37, 241 and 325 m^2/g, for samples A, B, and C, respectively. Those samples showed very different reactivity on the decomposition of chlorinated carbon components, which is speculated to be related to a different surface morphology. The fact that the samples were very fine powders gave a few technical difficulties in carrying out the AFM measurements, which were overcome by pressing the power into a pellet at a pressure of 12000 psi. Figure 1 shows the surface morphology of the samples obtained by AFM. As apparent from the micrograms, samples have dramatically different surface morphology. Sample A consists of plates which are ~200 nm wide and ~50 thick stacked together along one direction. The alignment of the plates is speculated to be caused by pressure applied during the preparation of the pellet. The sample C consists of spheres of a diameter of ~100 nm. The surface of the sample C is rougher than sample A. Sample B is rather similar to A, though the sample also had a feature of sample C: in some section of the pellet, spheres were observed mixed with the plates. These AFM observations are consistent with TEM studies carried out previously on similar samples, which revealed two different kinds of particles: sphere and plates. The difference in the morphology suggests that the identity of the most exposed crystalline facet and possibly of defects are not identical for the MgO samples. An effort to try to identify the facets of the particles is underway by carrying out the AFM measurements at atomic resolution.

IV. Students, Postdoctorals, and Research Associates Involved

Olga Koper, current Ph.D. student

Dong Park, postdoctoral research associate

Shawn Decker, current Ph.D. student

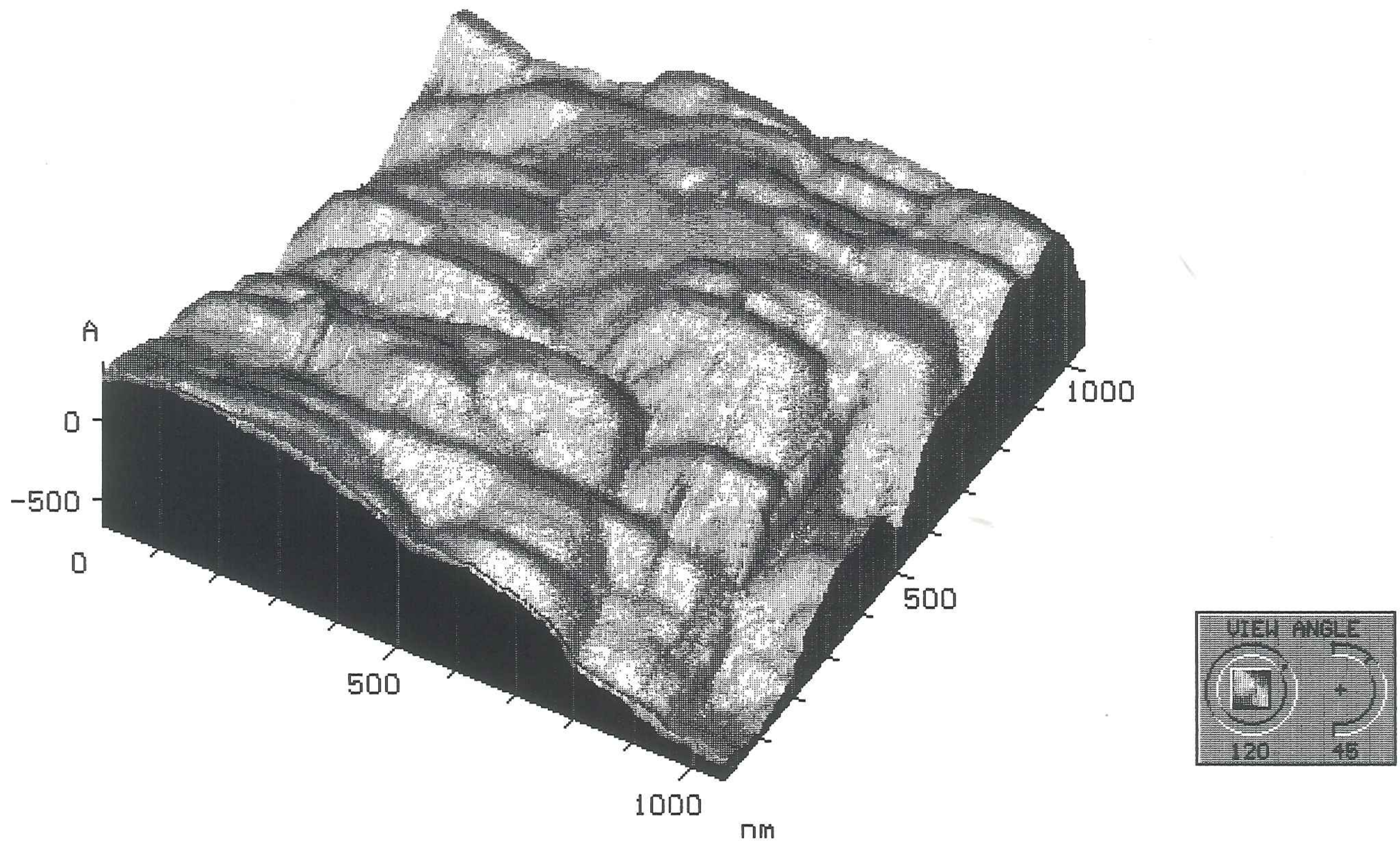
Yan Jiang, current M.S. student

A

New (17:31:54)

Surface Plot

May 23,1994 17:31:54



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B

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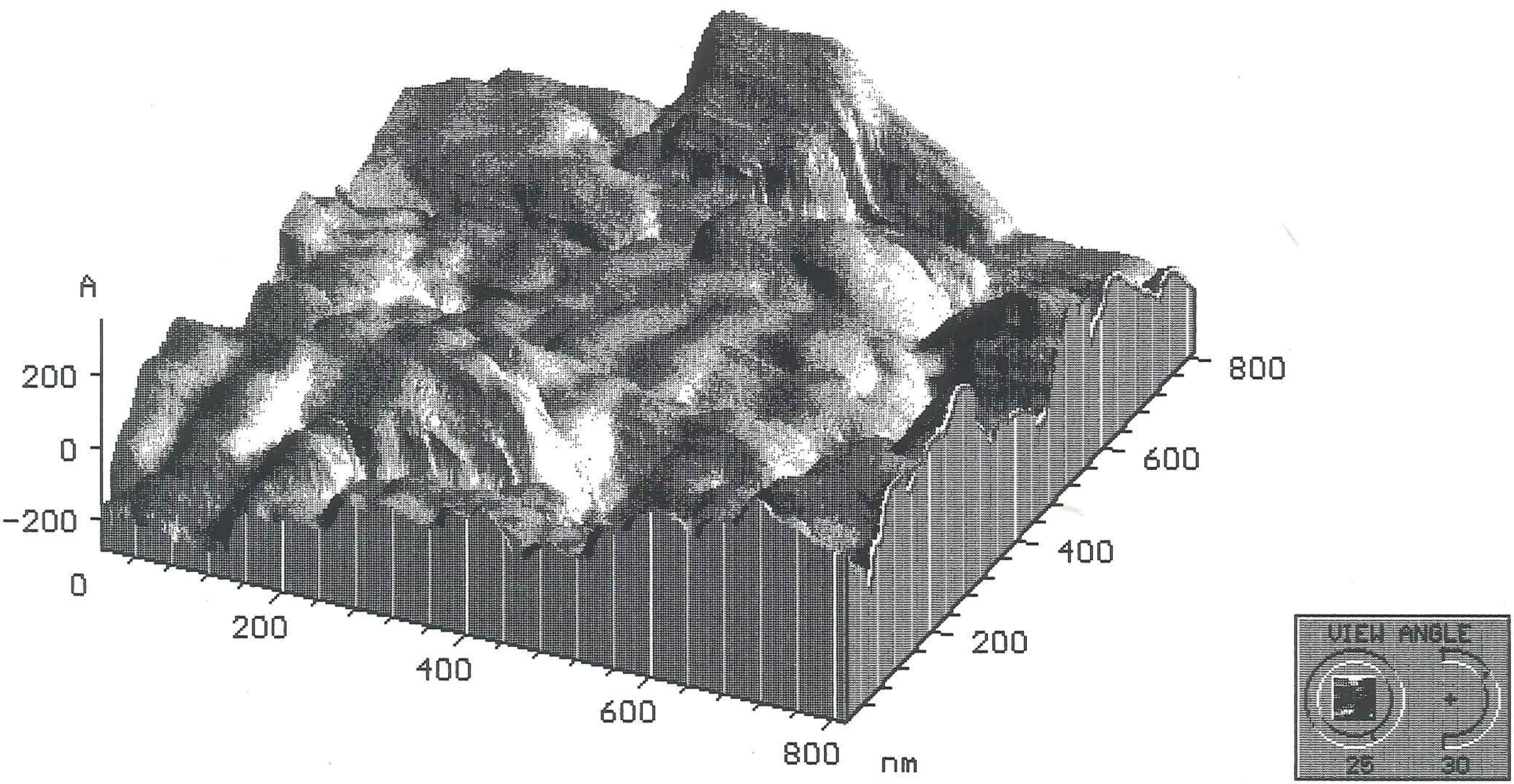
Surface Plot

May 06,1994 08:24:30



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C

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Surface Plot

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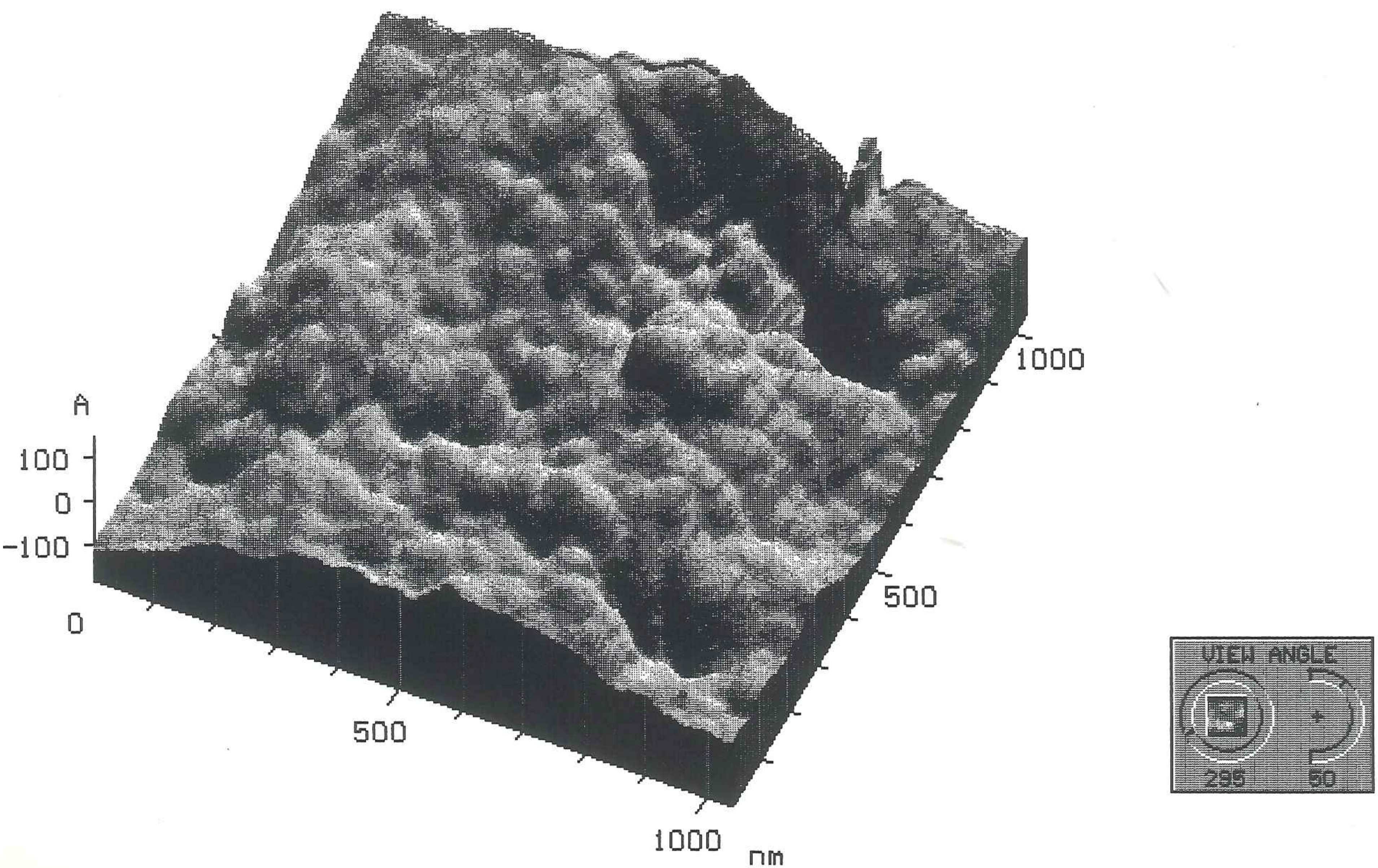

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